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Cutting Tool and Indexable Tip

Specification

The invention relates to a cutting tool for drilling and turning, comprising a base body featuring at least one coolant bore, with a clamping part and an essentially cylindrically formed working part following it in an axial direction, with an indexable tip releasably connected to it at its end opposite the clamping part, featuring in plan view circumferential cutting edges, which working part has a flute running in the direction of the tool axis and a form-locking seat for the indexable tip with cutting edges slightly projecting. Further, the invention relates to an indexable tip for such a cutting tool for the machining of materials, in particular metals and alloys, limited by a flat supporting area, a face opposite the supporting area and open spaces connecting the supporting area and the face, and with an attachment means mounting optionally embodied as a center hole, whereby in the plan view of the indexable tip, six cutting edges run circumferentially.

Cutting tools of the specified type, which can be used for different machinings, have an extraordinarily high technical and economic importance for the manufacture of work pieces, particularly those made of metal, in plant and machine construction. In a relatively short time, such cutting tools render possible the manufacture of a large number of work pieces, particularly those with complex geometric shapes, and can essentially ensure adequate dimensional accuracy and surface quality thereby. When several machining operations are performed with a single cutting tool, the machining time can be kept short, because expensive changeover times for exchanging cutting tools do not apply. In addition, with a computer-controlled machining of parts, the programming effort can be substantially reduced.

To meet the requirement for economic efficiency, for tools the achievement of as long a tool life as possible in practical use is required. For this reason, with cutting tools of the type mentioned at the outset, cutting attachments made of sintered materials featuring circumferential cutting edges

are used. The wear on the cutting edges or their length of use is influenced by several factors, e.g., a distribution of forces in the tip when in contact with the usually rotating work piece and/or the transfer of force from the tip to the base body.

In the production of work pieces of the highest quality, an appropriately ensured stability and a low tendency of the tool to vibrate with simultaneously good cutting action are necessary.

In order to further achieve the highest cost-effectiveness and surface quality, the cutting tools of the type mentioned at the outset should permit a variety of possible methods for machining work pieces, as well as feature the lowest possible tool wear, even in high capacity operation, and at the same time ensure a desired dimensional accuracy of the machined surfaces. However, the realization of such a combination of requirements is difficult to achieve.

In the published patent application DE 2733705, a cutting tool equipped with an indexable tip is described that is suitable for drilling and turning and whose indexable tip features four usable cutting edges. Two cutting edges each are located on the upper side and the underside of an indexable tip that is approximately rhomboid in plan view. The indexable tip is shaped such that a change of cutting edges occurs by turning, although the supporting area of the tip is reduced, by which the stability and thus also the surface quality achieved can be substantially impaired.

In EP 0642859 B1 another cutting tool for drilling into the solid and turning is suggested. The said cutting tool comprises essentially a base body and an indexable tip that is rhomboid in plan view, featuring alternately obtuse and acute angles, with four cutting edges rounded off at the corners and located on the upper side, whereby the tip is connected to the base body such that the front cutting edge in plan view runs vertically to the tool axis of rotation, does not deviate from the vertical more than a maximum of 0.5°, and does not extend more than about 10% beyond the tool axis of rotation at the transition to the corner rounding. It is further provided that in the front view of the tool, the cutting edge intersects the drill longitudinal axis or features a maximum spacing of

2% of the drill diameter. Such a cutting tool should feature improved stability and render possible a more even bore base in pocket bores. However, it can be considered detrimental for the tool that can be favorably used for drilling, that with turning and, in particular, an inside turning and die sinking with larger dimensions the largest chip width is limited to half the diameter of the machining section of the tool. Further, after a single turn of the indexable tip, this must be replaced for cutting edge wear and for cutting edge renewal.

The known cutting tools for drilling into the solid and for turning have the disadvantage in common, that the only machining widths to be achieved with them correspond essentially to the length of the face cutting edge and thus half the diameter of the machining part of the tool. Although a drilling outside the center optionally allows a slight increase of the bore diameter, this is limited to about 10% of the same. Experience has shown in operation that variable bore diameters even beyond this size are required, which, however, can only be achieved through the use of several different cutting tools or through an expensive machining technology. This is linked to a considerable loss of working time.

In addition, the cutting tools known from prior art are designed such that in plan view the indexable tip is mounted almost completely on one side of the base body or machining part of the tool between the surface and the axis of rotation. The uneven distribution of forces thus caused can result in vibrations and stability problems, through which on the one hand the tool life of the four cutting edges is reduced, and on the other hand the surface and work piece quality are adversely affected. It has also been shown that with cutting tools with cutting edges located on the upper side, because of the approximately square shapes of such indexable tips, an incorrect orientation of the same in the tip seat and a subsequent defective attachment can easily occur, particularly if tool users are under pressure, and thus hectic work methods and carelessness often result. Although attempts are made to prevent defective attachment and the consequent dangers for user and tool by additionally attaching signs on such indexable tips, such dangers cannot be ruled out.

The object of the invention is to remedy the above problems and aims to create a cutting tool for drilling and turning to meet high safety requirements with increased stability and the same tool life, with which cutting tool an increased width of machining is rendered possible and variable bore diameters within a wide range can be attained.

Another object of the invention lies in providing an indexable tip that is suitable for use in a cutting tool for drilling into the solid with variable diameters and for turning and that features a long tool life.

This object is attained in that with a generic cutting tool the indexable tip that is connected to the working part of the tool features in plan view a hexagonal shape with alternate obtuse and acute corner angles and six straight cutting edges and that the largest width of the indexable tip is at least 0.92 times the diameter of the working part.

The advantages of the invention can be seen in particular in that with a cutting tool according to the invention a drilling outside the center or axis is rendered possible and variable bore diameters can be attained. Bores can therefore be made in parts, the diameter of which can extend up to double the diameter of the working part of the tool.

The design of the drilling tool is made advantageously such that three cutting edges of the indexable tip can be activated in terms of machining technology and that the trajectory of a cutting edge or a part of the same, projects slightly beyond the outer contour of the working part during the rotation of the tool.

As drilling with increased machining width of the material and the same turning operations are likewise possible, in operation the number of machining steps and/or a complicated tool change can be advantageously reduced. The increased functionality of a cutting tool according to the invention therefore also causes the effect of improved cost-effectiveness.

A further advantage can be seen in that with a cutting tool according to the invention the number of cutting edges is increased by two compared with known generic cutting tools, and thus the tool life or the machining volume are increased by at least 50%. This can also be attributed to a preferred greater length of the cutting edges of the indexable tip.

Another advantage lies in a more stable positioning of the indexable tip. With a cutting tool according to the invention, the indexable tip is attached so that the enlarged supporting area in plan view comes to rest with considerable portions on both sides of the tool axis of rotation in the working part. A one-sided strain and a deformation of the cutting edge through elastic bending of the tool working part in operation is thus efficiently avoided. At the same time, according to the invention, with the same length of cutting edges, the supporting area or supporting surface of the indexable tip is enlarged, through which a favorable low contact pressure and a high stability are achieved. This allows the production of shaped bodies of the highest dimensional accuracy and surface quality with high cutting capacities.

In addition to the above advantages, a cutting tool according to the invention offers a favorably increased assembly safety. As far as the position of the cutting edges is concerned, there are indeed several, but only equivalent, possibilities for fitting them in the tip seat, due to the symmetry of the indexable tip. The result is that no safety hazard arising from false assembly occurs, even with hectic handling.

In a further development of a cutting tool according to the invention, the base body features one or more bores for inserting coolant and/or lubricants, whereby the exit of the coolant channel is directed at the indexable tip and in plan view thereby forms an angle of 15° to 75°, preferably 25° to 45°, with the tool axis. Due to this design, hot chips can be carried out and also the indexable tip, in particular the cutting edges and parts adjacent to the cutting edges, can be cooled and frictional forces can be reduced. In other words, the chip removal can be improved by a coolant, whereby it has proved particularly favorable for the durability of the cutting edges if the exit of the coolant

channel is directed at the indexable tip and thereby in plan view forms an angle of 15° to 75°, preferably 25° to 45°, with the tool axis.

For the further improvement of the chip removal, it has proved advantageous if the flute running in the direction of the tool axis is embodied with twist.

In a development of the invention to increase the stability of the attachment the indexable tip features a center hole and is connected to the base body via this by means of a screw.

In order to achieve optimum dimensional accuracy and the same surface quality of the machining, it was judged advantageous if the cutting edges of the indexable tip in plan view form an angle of 88°± 1.7°, preferably 88° ± 0.5°, in particular 88° ± 0.3°, at their acute-angled corners.

In order to achieve a flat drilling base with simultaneous high stability of the cutting tool and a good freedom of movement during drilling, it has proved favorable if in plan view a front cutting edge of the indexable tip forms an angle of 89.8° ± 0.5° with the tool axis of rotation.

The further object of the invention to prepare an indexable tip that is provided for a cutting tool for the machining of materials, in particular metals and alloys, by drilling and turning, limited by a flat supporting area, a face opposite the supporting area, and open spaces connecting the supporting area and the face, and features an attachment means mounting, whereby in the plan view of the indexable tip, six cutting edges run circumferentially, is achieved in that straight cutting edges in plan view form alternately acute-angled corners and obtuse-angled corners, whereby the vertical distance of the cutting edges from the base area features a minimum in the area of the obtuse-angled corners.

The advantages of an indexable tip according to the invention are to be seen in particular in that through its use in a cutting tool, variable bore diameters can be attained in drilling outside the

center of the tool and that an extraordinarily high cost-effectiveness is given by the availability of six usable cutting edges. The offset cutting edge can have an effective machining action over the entire width of the indexable tip thereby.

In an advantageous development, the cutting edges of an indexable tip according to the invention form an angle of 88°± 1.7°, preferably 88° ± 0.5°, in particular 88° ± 0.3°, at their acute-angled corners, as a result of which a high dimensional accuracy with a minimizing of the chip separation vibrations can be achieved, in particular during drilling and die sinking.

To attain a high cutting action, it can be advantageous if the cutting edges of an indexable tip according to the invention are embodied inclined to the supporting area at an angle of 2° to 10°, preferably 4° to 8°, in particular 7° ± 0.5°.

The cutting capacity can be increased if the part of the face of an indexable tip according to the invention immediately bordering the cutting edge forms an angle of 2° to 18°, preferably 4° to 12°, in particular 5° to 10°, with the supporting area. This corresponds to a particularly advantageous establishment of the rake angle as far as the cutting action and chip removal are concerned.

In a further advantageous development, an indexable tip according to the invention is characterized by open spaces that form an angle of 5° to 12°, preferably 6° to 11°, and in particular 7° ± 0.5°, with the normal to the supporting area at the cutting edges or that are optionally divided into at least two sections of which the first, bordering the cutting edges, forms an angle of 5° to 12°, preferably 6° to 11°, and in particular 7° 0.5°, and the last of which, bordering the supporting area, forms an angle of 12° to 25°, preferably 14° to 22°, and in particular 15° ± 0.5°, with a straight line normal to the supporting area. Through this development, a particularly good freedom of movement is achieved when used in a cutting tool according to the invention.

To establish a desired surface roughness, an indexable tip according to the invention can feature rounded-off corners with a specified corner radius.

The invention is explained below in greater detail on the basis of illustrations of an exemplary embodiment. It is understood hereby that the embodiment explained in greater detail represents merely one way to realize the invention.

Fig. 1 shows a cutting tool according to the invention in plan view.

Fig. 2 shows a cutting tool according to the invention in side view.

Fig. 3 shows an indexable tip according to the invention in front view.

Fig. 4 shows an indexable tip according to the invention in plan view.

Fig. 5 shows an indexable tip according to the invention in side view.

Fig. 6 shows the section along line AB in Fig. 4.

Fig. 7 shows the making of a drilled hole in a work piece by drilling outside the center with a cutting tool according to the invention.

Fig. 8 shows the making of a pocket bore in a work piece using a cutting tool according to the invention.

In Fig. 1 a cutting tool according to the invention is shown in plan view by way of example. Such a cutting tool comprises essentially a base body (1) with a clamping part (2) and a working part (3) following it in an axial direction, whereby a coolant channel (32) passes through the base body in the direction of the axis of rotation (A) and can feed coolant to an exit (321), with the result that coolant can be allowed to flow through this exit (321) to the front region of the working part (3) for cooling and/or chip removal. The working part (3) features a form-locking seat (33) for accepting an indexable tip (4). An indexable tip (4) featuring a hexagonal shape in plan view with alternately obtuse and acute corner angles is mounted in the form-locking seat (33) such that the width (B) of the largest dimension of the indexable tip corresponds approximately to the diameter (D) of the working part (3) and three cutting edges project slightly. An active front cutting edge (40) in plan view stands at an angle of 90° to the axis of rotation (A). Fig 2 shows the side view of a cutting tool

according to the invention. The design of a twisted flute (31) running in the direction of the axis of rotation (A) renders possible an advantageous chip removal.

Fig. 3 shows by way of example the front view of an indexable tip (4) according to the invention, which indexable tip (4) is formed by a flat supporting area (41), a face (42) opposite the supporting area (41), and open spaces (43) connecting the supporting area (41) and the face (42). The plan view of an indexable tip (4) according to the invention is illustrated in Fig. 4. The indexable tip (4) features straight cutting edges (40, 40^{I}, 40^{II}, 40^{III}, 40^{VI}, 40^{V}), which in plan view form alternately acute-angled corners (44, 44′, 44″), and obtuse-angled corners (45, 45′, 45″) and whose vertical distance from the supporting area in the region of the obtuse-angled corners (45, 45′, 45″) exhibits a minimum. Fig. 5 shows a corresponding side view. An attachment means mounting embodied as a center hole (46) passes through the indexable tip (4), through which the mounting of a screw is rendered possible. Fig 6 shows a section along the line AB featured in Fig. 4. The part (421) of the face (42) adjacent to the cutting edges is inclined with respect to the supporting area (41), through which a good cutting action can be achieved during use in a cutting tool.

Fig. 7 shows an exemplary use of a cutting tool (1) according to the invention concerning the making of a bore (51) in a work piece (5). The work piece (5) rotating around a work piece axis (W) is moved straight forward in the direction of the cutting tool (1), through which chips are separated from the work piece (5) by means of the cutting tool (1). The diameter (L) of the bore made (51) is essentially determined thereby by the offset (V) of the work piece axis (W) and the axis of rotation (A) of the cutting tool (1). In Fig. 8 a further use of a cutting tool (1) according to the invention is illustrated by way of example. In a work piece (5) with a bore (51) made with a first diameter (L), a flat pocket bore can be achieved in a simple manner by making a bore with a diameter (L1), which diameter (L1) is greater than the first diameter (L), by means of drilling outside the center, and subsequently separating the hole plug (521) of the second bore (52) by turning.

Claims

1. Cutting tool (1) for drilling and turning comprising a base body featuring at least one coolant bore (32), with a clamping part (2) and an essentially cylindrically formed working part (3) following it in an axial direction, with an indexable tip (4) releasably connected to it at the end opposite the clamping part, featuring in plan view circumferential cutting edges, which working part has a flute (31) running in the direction of the tool axis and a form-locking seat for the indexable tip with cutting edges slightly projecting, characterized in that the indexable tip (4) connected to the working part (3) of the tool features in plan view a hexagonal shape with alternately obtuse and acute corner angles and six straight cutting edges and that the greatest width (B) of the indexable tip (4) is at least 0.92 times the diameter (D) of the working part.

2. Cutting tool (1) according to Claim 1, characterized in that three cutting edges of the indexable tip (4) can be activated in terms of machining technology and that the trajectory of a cutting edge or a part of the same, projects slightly beyond the outer contour of the working part during the rotation of the tool.

3. Cutting tool (1) according to Claims 1 or 2, characterized in that the base body features one or more bores (32) for inserting coolant and/or lubricant, and the exit (321) of the coolant channel (32) is directed at the indexable tip (4) and in plan view forms an angle of 15° to 75°, preferably 25° to 45°, with the tool axis (A).

4. Cutting tool according to one of Claims 1 through 3, characterized in that the flute (31) running in the direction of the tool axis is embodied with twist.

5. Cutting tool according to one of Claims 1 through 4, characterized in that the indexable tip (4) features a center hole (46) and is connected to the working part (3) of the base body via

this through an attachment outside the center.

6. Cutting tool (1) according to one of Claims 1 through 5, characterized in that the cutting edges form an angle of 88°± 1.7°, preferably 88° ± 0.5°, in particular 88° ± 0.3°, at their acute-angled corners.

7. Cutting tool (1) according to one of Claims 1 through 6, characterized in that in plan view a front cutting edge of the tip forms an angle of 89.8° ± 0.5° with the tool axis of rotation.

8. Indexable tip (4) for a cutting tool, in particular for one according to the previous claims, for the machining of materials, in particular metals and alloys, limited by a flat supporting area (41), a face (42) opposite the supporting area (41) and open spaces (43) connecting the supporting area and the face, as well as with an attachment means mounting (46) optionally embodied as a center hole, whereby in the plan view of the indexable tip, six cutting edges run circumferentially, characterized in that straight cutting edges (40, 40^{I}, 40^{II}, 40^{III}, 40^{VI}, 40^{V}) in plan view form alternately acute-angled corners (44, 44′, 44″) and obtuse-angled corners (45, 45′, 45″) and that the vertical distance of the cutting edges from the supporting area (41) in the region of the obtuse-angled corners (45, 45′, 45″) exhibits a minimum.

9. Indexable tip according to Claim 8, characterized in that the cutting edges form an angle of 88°± 1.7°, preferably 88° ± 0.5°, in particular 88° ± 0.3°, at their acute-angled corners (44, 44′, 44″).

10. Indexable tip according to one of Claims 8 or 9, characterized in that the cutting edges (40) are embodied inclined at an angle of 2° to 10°, preferably 4° to 8°, in particular 7° to 0.5°, to the supporting area.

11. Indexable tip according to one of Claims 8 through 10, characterized in that the part of the

face (421) immediately bordering the cutting edge forms an angle of 2° to 18°, preferably 4° to 12°, in particular 5° to 10°, with the supporting area (41).

12. Indexable tip according to one of Claims 8 through 11, characterized in that the open spaces (43) form an angle of 5° to 12°, preferably 6° to 11°, in particular 7° ± 0.5°, with a straight line normal to the supporting area (41) at the cutting edges (40, 40^{I}, 40^{II}, 40^{III}, 40^{VI}, 40^{V}) or are optionally divided into at least two sections (431, 432), of which the first (431), bordering the cutting edges, forms an angle of 5° to 12°, preferably 6° to 11°, and in particular 7° ± 0.5°, and the last of which (432), bordering the supporting area (41), forms an angle of 12° to 25°, preferably 14° to 22°, and in particular 15° ± 0.5°, with a straight line normal to the supporting area (41).

13. Indexable tip according to one of Claims 8 through 12, characterized in that the corners (44, 44′, 44″, 45, 45′, 45″) of the indexable tip are rounded off.

Abstract

The invention relates to a cutting tool (1) for drilling and turning comprising a base body featuring at least one coolant bore, with a clamping part (2) and an essentially cylindrically formed working part (3) following it in an axial direction, with an indexable tip (4) releasably connected to it at its distal end, featuring in plan view circumferential cutting edges, which working part has a flute (31) running in the direction of the tool axis and a form-locking seat (33) for the indexable tip. According to the invention it is provided that the indexable tip (4) connected to the working part (3) of the tool features in plan view a hexagonal shape with alternately obtuse and acute corner angles and six straight cutting edges and that the greatest width (B) of the indexable tip (4) is at least 0.92 times the diameter (D) of the working part.